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MOST IMPORTANT ERRORS

IN

CHEMISTRY,

ELECTRICITY, AND MAGNETISM,

POINTED OUT AND REFUTED;

AND THE

PHENOMENA OF ELECTRICITY,

AND THE

POLARITY OF THE MAGNETIC NEEDLE

ACCOUNTED FOR AND EXPLAINED.

BY

A FELLOW OF THE ROYAL SOCIETY.

[W. F. Stevenson]

"Naturam expellas furcâ tamen usque recurret."—Hor.

LONDON:

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PREFACE.

"HUMANUM est errare."—The object of the present tract is to draw the attention of men of science, to what the author believes to be most pernicious errors in Chemistry, Electricity, and Magnetism; namely, that water is decomposable, that hydrogen is an elementary body, and that there are two kinds or states of Electricity and Magnetism; and to point out the true mode of action of these fluids.

If the errors in question should turn out to be mere fragile creations of the author's brain, no possible evil can result from this publication.

If, on the contrary, they should be found to have a real existence, of which the author has the fullest conviction, there can be no doubt that incalculable benefit must ensue by the removal of these mischievous intruders from the avenues of science,

293

where they cannot but very seriously impede our approach to the sacred temple.

These considerations, the author trusts, will be received as an apology for his venturing to obtrude his ideas on the public attention.

Well House, Malvern Wells,
28*th Sept.* 1846.

MOST IMPORTANT ERRORS,

&c. &c.

NOTWITHSTANDING the eulogium passed upon Sir Humphry Davy by his admirable biographer, Dr. Paris, if we except the Safety Lamp,* we do not appear to be so much indebted to his labours as is generally imagined; nor has chemistry been left by him at all in a satisfactory state. He is said to have overthrown the theory of combustion of Lavoisier, and to have proved that oxygen is not the principle of acidity; but what has he substituted in their place? Instead of light and heat being properties of oxygen, which that substance parts with or developes at the time of its union with a combustible body, (according to the French chemist), Davy tells us that light and heat are the mere effects of motion,

* The efficacy of this lamp is due to the very unexpected discovery that flame will not pass through the interstices of a metallic wire gauze, (and which Dr. Paris allows a celebrated engineer claims to have found out before Sir Humphry), as the miners already knew that the "fire damp" would not explode *in the absence of flame*. It is then not to Sir Humphry Davy as a chemist, but as a mechanist, that we are indebted for this useful instrument.

or, as he terms it, of "intense chemical action;"* and with respect to the cause of acidity, he leaves it wholly unaccounted for. He is said, again, to have enriched science with some evanescent metals that are supposed to be the bases of alkaline earths; but which will most probably turn out to be only compound bodies, as Mr. Curadon asserted, in his memoir read at the French Institute.

But what could the greatest genius effect without a knowledge of the materials upon which he worked, or of the tools which were to aid him? Now of what can these consist but of elementary substances, and what do chemists know of elementary bodies? If we are led to suppose that it is one of the excellencies of Divine wisdom to arrive at the most astonishing results by the simplest of means, it would naturally follow, that to make any considerable progress in chemistry we should adopt a similar course. Instead of this, we have now upwards of fifty elementary bodies; so injudiciously have we multiplied the four simple elements handed down to us from antiquity.

Our immortal countryman, Bacon, seeing the error of raising up systems without ascertaining the facts by which they were to be upheld, enforced the necessity of experiment for supplying these desiderata. But we now fall into the other extreme, and are daily multiplying experiments and pro-

* And yet, by other experiments, Davy found the most vivid effects of combustion known (light and heat), were those produced by the *condensation* of oxygen and chlorine.

ducing results without having any clear or definite object—thus making "confusion worse confounded."

In fact, modern chemistry looks very much like a scramble for popularity. Instead of pondering on and scrutinizing some few of the million of experiments already made, which invite investigation, it seems to be the only question, who can run the fastest on the road to novelty; and he who contrives to pick up some wild apple in his route, which has a little more colour in its cheeks than ordinary, is forthwith crowned with public applause, to the great envy and disappointment of his breathless competitors.

With these remarks, for which I beg to apologize, I shall proceed to the consideration of the errors in question.

Preliminary to our examining the experiments relative to the "decomposition of water," let us consider, for a few moments, upon what authority, independently of chemistry, this fluid may be considered as an elementary body: not that I mean for one moment to contend that scriptural, or any other authority, is to preclude a conclusion against direct evidence; but merely, that if a strong doubt should be raised upon the subject, the Old Testament, the dicta of ancient philosophers, and the doctrine of probabilities, may be allowed their fair weight in deciding the question, and induce chemists to adopt that view of the subject *until* the contrary shall be shewn by unanswerable experiments; as there is, I

think, great reason to believe that the facility with which Cavendish's theory has been received, has placed chemistry in a worse condition than during the reign of the alchymists.

We find then, in the first chapter of Genesis, that "God created the heaven and the earth," and afterwards that "the spirit of God moved upon the face of the waters."*—Again, that "God said, Let the waters under the heaven be gathered together unto one place, and let dry land appear. And God called the dry land earth."

From these passages it would seem, (and the contrary is not stated in the rest of Genesis) that the water must have been *previously* created, and not at the time the heaven and the earth are spoken of. It also appears, that in the first instance the waters entirely covered the earth.

Thus we find in one other passage, which I will beg leave to quote, as it is not a little remarkable, and has hitherto, I believe, escaped notice, these words: "And God said, Let there be a *Firmament* in the *midst* of the waters, and let *it* divide the waters from the waters." Now it is a curious circumstance that the Hebrew word which is translated into "Firmament," signifies "*Expansion*,"† from which

* A French author says that "water is the most noble of elements, seeing that it was upon the water that God was carried *before* the creation of the world."

† See note on the word "Firmament," 1st chap. Genesis, v. 6. Oxford edit. 1834.

it must be inferred that the earth was a *nucleus* in *fusion*, surrounded by the aqueous fluid from which it partially disengaged itself by *expansion*, and thus caused dry land to appear.

If then we apply eastern metaphor to the seven days' creation, we have in Genesis a clear and distinct confirmation of the present theory of the origin and constitution of our planet. So far the Scriptures.

We have now the great authority of Aristotle, who states water to be one of the four elements. When we bear in mind that the Grecian and Roman philosophers were men of a mental calibre vastly superior to our own, of which we have the most indisputable proofs in the monuments they have left behind in all the branches of learning—(viz. Poetry, Eloquence, History, Philosophy, Architecture, Strategy, and the Arts)—we cannot suppose that those elements were given without great consideration; and we know that the ancients were not influenced in this respect by the Jewish Sacred Writings, to which, (if they were acquainted with them) they certainly paid no deference.*

If it be said that with all their superiority they were not chemists, I think that observation gratuitous, and the fact extremely improbable; for when Sir Humphry Davy was engaged with the Admiralty, upon his electro-chemical process for protecting the sheathing of our ships (a scheme which,

* "Credat Judæus Apella, non ego!"—Hor.

after a very great expenditure, was at length abandoned), it was found, from the discovery of an old Roman galley of the time of Trajan, that they were acquainted with this electro-chemical action, and had applied it to the ship in question, the bottom being found coated with leaden sheets, fastened with copper nails.*

Now, then, let us consider this question upon the ground of probability. I have already observed that the highest conception we can have of Divine power, is that of producing the most splendid results by the simplest means; and whenever we are able to comprehend any of the processes of nature, we find this invariably to be the case.

Is it probable, then, that the water of our globe, now three times in extent to that of the earth, and which, at the time of the creation, must have been still more capacious, as much of it must have been

* Marchetti, cited by Dr. Paris, to whose excellent work I am indebted for much of the matter upon which I shall have to comment.

There are two reasons why the scientific works of the ancients are not familiar to us. First—That after the fall of the Roman Empire, the monks, being in all probability unacquainted with science, would only preserve such works as related to literature, and of those only such authors as had been known by their great celebrity. Secondly—That if some few of the monks were not ignorant of science, still manuscripts of that description would be much more rare than the former, and the religious fanaticism of the age would militate against their preservation.

volatilized to form an atmosphere ;* is it probable, I ask, that so important a body to the existence and comfort of the inhabitants of the earth, and on that account so bountifully supplied, should be a compound of gaseous substances, the quantities whereof to form such a body far exceed the stretch of human imagination, though the latter be elastic enough to adopt the calculation of Mr. Arago, that the velocity of light is seventy-seven thousand leagues in a *second* of time ?

We cannot, therefore, suppose such a combination of gaseous matters, without adopting the unphilosophical notion of an overwhelming necessity.

We have then added to the great improbability, both scriptural authority and the opinion of the ancient philosophers against this doctrine.

We will now proceed to an examination of the experiments by which the composition of water is said to be established.

It will be but just to premise, that the investigation of an important process, and the repetition of such process by an *advocate* of the doctrine, is a very different affair from the scrutiny and repetition of the same experiment by an opponent, and this, notwithstanding there should exist not the remotest doubt as to the *bona fides* of the operator.

I cannot enforce this remark better than by

* Davy says, "the atmosphere always contains water in the elastic and invisible form, varying in quantity with the temperature."

quoting the sentiments of Sir Humphry Davy upon this point in the fifth dialogue of his "Last Days of a Philosopher." "By *often* repeating," he says, "a process or an observation, the errors connected with hasty operations or imperfect views are annihilated; and, *provided the assistant has no preconceived notions* of his own, and is *ignorant of the object of his employer* in making the experiment, his simple and bare detail of facts will often be the best foundation for an opinion."

Now, we collect from this, the extreme danger of being deceived by an experiment, (though the greatest apparent care may have been used) wherever the operator's mind has been imbued with the idea of what ought to be the result of such experiment; and infinitely more so must it be where the good wishes of the operator have accompanied the expectation of such a result.

I feel these remarks necessary, as the observations of Davy strongly apply to the processes connected with the decomposition of water, and which can by no means, therefore, be implicitly relied upon; and the less so, as there exists an extreme difficulty in conducting the experiments, as will be presently seen.

The experiment consists in putting *pure water* into a glass vessel hermetically closed, and by the introduction of the galvanic fluid through the application of the voltaic pile, decomposing the water in question, so that upon the termination of the pro-

cess, no water is found in the vessel, but in lieu thereof, hydrogen and oxygen gases, in the proportion of two parts of the former to one of the latter, according to Davy; but, according to Cavendish, only one of hydrogen and five or six of oxygen.*

This is said to have been effected, first by Cavendish, and subsequently by Lavoisier, Wollaston, Davy, &c., all of whom, be it observed, gloried in the discovery; and, indeed, the two last, in common with many other celebrated characters, considered Cavendish as having by this process contributed additional rays to the splendour which Newton had already shed upon this our highly-favoured country.

To render the process in question decisive, two things are indispensable, viz. that at the commencement of it, the water should be wholly free from oxygen; and that, during the operation, no oxygen should find its way into the vessel.

Now, I think it will clearly appear, that none of the experiments made upon water have been free from these objections, in which case they are valueless as evidences of any decomposition having been effected.

To shew the extreme difficulty, nay, the almost impossibility, of obtaining pure water, and when partially obtained, of preventing the ingress of oxygen, (it either entering with the galvanic fluid,

* M. Dumas, the celebrated French chemist, says, that one part of hydrogen and *eight* parts of oxygen form one atom of water. See *Annales de Chemie. June*, 1842.

or in some other undiscoverable manner) I will quote the following experiment, taken from Davy's Bakerian Lecture, delivered on the 26th November, 1806.

Mr. Sylvester had asserted, that if two separate portions of water were electrised, out of the contact of substances containing alkaline and acid matter, acid and alkali would nevertheless be produced.* "Some persons," says Dr. Paris, "thought that *the salts contained in the fluids of the troughs of the voltaic pile might, by some unexpected channel, find their way into the water under examination.* Others, *that they were generated by the union of the electric fluid with the water*, or with one or both of its elements."

Davy's anxious desire was, however, to test and overthrow Sylvester's experiment.

For this purpose, and to avoid all possible impurity in the water, Davy used two small cups of agate, which were boiled for several hours in distilled water, and a piece of very white and transparent amianthus (a substance first proposed by Dr.

* M. de la Rive, the ingenious Professor of Chemistry at Geneva, says, that in all the experiments on water by the voltaic current, *oxygen* is disengaged at the surface of the metallic poles, arising from minute particles of metal oxydated, and which are suspended in the current, and are thus conveyed into the vessel containing the water; and M. de la Rive, be it observed, is a believer in the decomposition of water.—See *Archives de l'Electricité*, by M. de la Rive, and which contains all the experiments upon this subject.

Wollaston) similarly purified, was made to *connect* the vessels together.

Thus we see, says Davy, that every apparent source of fallacy was removed; but, nevertheless, after the *purest distilled water* had been exposed in the agate cups to the voltaic current for forty-eight hours, the water in the positive cup gave indications of muriatic acid,* and that in the negative cup of soda.

Thus, then, had oxygen either existed in the water, and formed the acid; or it must have resulted from the acid mixture in the trough, or from oxydated matter transmitted by the poles of the voltaic battery,

The experiment was therefore repeated by Davy a second, third, and fourth time; the agate cups having been carefully placed in glass vessels, out of the reach, says Davy, of any circulating air; and all the materials having been repeatedly washed with distilled water, and no part of them in contact with the fluid having ever touched the fingers—*but still the same result.*

The experiments were, in consequence, again re-

* Dr. Priestley always denied that *pure* water *was ever produced* by the combination of hydrogen and oxygen. He observes, that in *all* his experiments an *acid liquor* was the consequence. In these experiments of Dr. Priestley there can be little doubt that the acidity was occasioned by the oxygen uniting with the water which had resulted from the deflagration of the hydrogen, as the action of the voltaic current would not have been long enough to supply any oxygenated matter aliundè.

peated, and instead of agate cups, small cones of the *purest gold* were used, and the water contained in them submitted to voltaic action for 14 hours; the result was, the water in the positive cup *became acid, which increased in quantity as the experiment proceeded, and at length became sour to the taste.* On the contrary, the alkaline property of the fluid in the opposite cone shortly obtained a certain intensity, and became stationary. The acid, as far as its properties could be examined, agreed, says Davy, with those of pure nitrous acid, *having an excess of nitrous gas.*

With these results Davy was again dissatisfied. Now let it be particularly remarked, that you have here a chemist exerting all his energies to overthrow a theory which he thinks proper to oppose; whereas, in the experiments on the decomposition of water, you have all the chemists exerting themselves to confirm a theory by which they suppose they are to acquire two additional elements to enrich the stores of chemical science.

This forcibly illustrates the pungency of Davy's remarks, of the necessity of the operator having no preconceived notions about the result, and, at all events, that he should be exempt from any prejudice or wish upon the subject.

Davy now submitted the *water* to a still more rigorous examination, which he did by *evaporating* it in a silver vessel, when he discovered 1-70th of *a grain* of saline matter.

The water thus purified was again subjected to a voltaic current in the cones of gold.

In *every one of these experiments*, says Davy, *acid matter was produced* in the positive cup, and always with the character of *nitrous acid.* How this acid could arise, says Davy, (determined, as we see he was, that Mr. Sylvester should not be right) he could not imagine. It occurred to him at last (he observes) that the "*nascent oxygen and hydrogen* of the water might combine with the *common air, which is constantly dissolved in that fluid;*" (and this he supposes possible, notwithstanding the water had been so carefully purified)—but how did it happen, he adds, that the production of *nitrous acid was progressive?* Davy then remarks that he recollected some experiments of Priestley on the absorption of gases by water, and of the difficulty of their exclusion, and he therefore introduced the two golden cones containing the purified water under the receiver of an air pump, when the exhaustion was effected, and the voltaic pile brought to act upon the water thus further purified. After 18 hours, the result was examined, when the water in the negative cone produced no effect upon prepared litmus, but that in the positive cone *did give a tinge of acid*, barely perceptible. Thus ended the process. But there is every reason to suppose, I submit, from his previous experiments, that had he *continued* the voltaic current for 48 hours instead of 18, the water, notwithstanding the action of the air pump, would have gone on *progressively increasing*

in acidity. Indeed, it must be admitted that in candour he ought to have continued the last process as long as he had done the first, when he used the agate cups.

We see, then, from these experiments, that the ability of the most able artist in chemistry is incapable of excluding oxygen from entering into the vessels, and combining with the water.*

There can be no doubt that water in its pure state contains neither acid nor alkali; and it is equally indisputable that these matters are conveyed to the water by the voltaic current, and that the proportion of alkali is very trifling compared with that of the acid.

It is equally plain that if these matters are communicated by the voltaic fluid, the longer the operation continues the more they, at least the acid, will impregnate the water.

I now confidently appeal to every impartial chemist, and ask, whether in any of the processes recorded, either of Cavendish, or any other of the chemists who have repeated his experiments, the water acted upon by the voltaic current was in anything like the state of purity; or whether anything like the same means were taken to produce such purity, as we find to have been adopted in the

* If the water in Davy's first six experiments was free from oxygen, it is evident that Sylvester is right, and that oxygen is (as M. de la Rive also insists) carried with the electric current, and thus enters the vessel containing the water. If, on the other hand, the water always contained oxygen, then no satisfactory conclusion can be drawn from the experiments.

processes I have just mentioned? and if such has not been the case, I ask what satisfactory evidence exists of water being decomposed? Is there any man who can say that he is now perfectly satisfied that such a result has taken place?

I will now produce a strong and direct argument from Davy himself against any such decomposition.

In considering the action of the voltaic pile, Davy says—"He thought that *if the fluid medium of the pile, could be a substance incapable of decomposition,* there is every reason to believe the equilibrium of the two opposite metals would be restored, *and the motion of electricity cease.*"*

Now at a subsequent period we find Sir Humphry Davy stating—"that *pure water* does not act upon the voltaic pile;" and he makes this observation, "the galvanic pile only acts as long as the water between the plates *holds some oxygen in solution.*" *Has he not found then in water the "indecomposable fluid medium,"*† the effect of which, he says, will be to suspend the motion of electricity?

According to Davy, if water were decomposable, it would be decomposed by the action of the metallic plates—instead of which the plates cannot eliminate any oxygen from it.

But a still stronger, and as it appears to me, unanswerable argument against any such decomposition is this. In the processes just mentioned we find that Davy connected the agate cups and golden

* Dr. Paris's Life of Davy, vol. i. 246. † Ib. vol. ii. 210.

cones together with amianthus, and placed them in glass vessels hermetically closed; and that the small quantities of water contained in these agate cups were submitted to the action of the powerful voltaic pile of the Royal Institution for forty-eight hours, and which experiment was repeated a second, third, and fourth time; and that the water in the golden cones was so acted upon for eighteen hours, and yet that these insignificant portions of water stood this intense voltaic action *without being decomposed!*

It is evident that Davy, in the ardour of his pursuit, and the exultation of an *imaginary* victory, (for no impartial man can believe it to have been gained), never once reflected that he was giving conclusive testimony to the fallacy of the experiments in which water had been thought to be decomposed.

He speaks indeed, as we have seen, about *a conjecture*, that there *might be* some *nascent hydrogen and oxygen*, wholly forgetting that according to Cavendish, Lavoisier, Wollaston, and himself, the whole of the water in each of these operations ought to have been resolved into thin air.

Then I ask whether it does not result from these experiments of Davy--whether in fact it is not manifest, that when Cavendish found that hydrogen and oxygen were produced by the action of the electric fluid upon the water, the hydrogen must have owed its origin to a combination of the water with the electric fluid, and that the oxygen must at the same time have been liberated

from the water where it had previously been held in solution; or have been introduced by the voltaic current.*

As for the experiment by which hydrogen and oxygen are supposed to produce water by their union, effected through the agency of the voltaic current, it proves nothing. For if hydrogen be compounded of electricity and water, the result of the combustion of the two gases would be, that the hydrogen would restore the water, which would then absorb the oxygen, thereby rendering the *water acid;* and which agrees with Dr. Priestley's statement, when he says that in all his experiments upon these gases the water resulting from them *was invariably acid;* and he denies that *pure water* could be procured from their combination.

But surely if water has been decomposed, there can be no doubt of the proportions of the elements which constitute this fluid? Or have the experiments been effected with so little precision that the true quantities of gas cannot be ascertained? One would suppose such a query as this, in a process of so much magnitude, would be altogether an insult; and yet, strange as it must appear, the fact is so. Davy says that two of hydrogen and one of oxygen are the constituents of water, which does not coincide with Cavendish, who says that there is one of hydrogen to five or six of oxygen, while the able

* Further oxygen would have been introduced by the voltaic current, according to Davy's experiments and the observation of M. de la Rive.

French chemist Mr. Dumas, insists that, from recent experiments made by him, one part of hydrogen and eight of oxygen form an atom of water.

Is it, then, too much to say, that when a chemical process is left in such a state as this, very little account ought to be taken of it?

With regard to hydrogen, we find every experiment connected with it pregnant with evidence of its being a phlogistic matter combined with water. The Stahlian Theory then after all is correct, and Scheele, Priestley and Watt, were perfectly right in upholding the Phlogistic Doctrine. Nay, even Cavendish, notwithstanding his supposed decomposition of water, (in which neither Priestley nor Watt believed) held that hydrogen was a compound body.* But here, unfortunately, Science remained stationary. It never occurred to either of these able chemists that the phlogistic matter could be no other than the electric fluid. If this had but once flashed across their minds, the fallacy of water not being an element must have been manifest, and chemistry would then have flourished in her onward course.

The more the nature of hydrogen is investigated the more clearly we perceive its connection with electricity, or the galvanic fluid.

Let us, for instance, consider the gas of the coal-mines,† called "fire damp." This matter, accord-

* Vide postea, p. 25.

† Dr. Priestley (who disbelieved in the composition of water), procured his hydrogen by *distilling well burnt charcoal*, when he obtained hydrogen and carbonic acid in nearly equal volumes.

ing to Davy's analysis of it, is "carburetted hydrogen," which, he says, by the admixture of *not less* than six times its volume of atmospheric air—explodes; and the result of which explosion is, as we know, that the vaults or passages of the mine *run down with water.*

It will be important then to look at the quantity of this carburetted hydrogen found in the mines. In one colliery alone, belonging to the Lowther family, the miners had picked a hole, from which *a uniform current* of the gas continued to issue for the space of two years and nine months;* and out of the fissures which the men had cut, there had issued *seven hundred hogsheads of carburetted hydrogen in a minute; and this quantity of gas continued to be emitted for years.*

Now then we have here a most extraordinary and magnificent *decomposition* of water. When we find that the separation of the elements of water is attended with the difficulty we have recently seen, can any man believe that the hydrogen gas in question is the result of any such decomposition? when we are told too that a powerful voltaic current for forty-eight hours, only "*suggests the idea of nascent* hydrogen and oxygen?"

But a still more embarrassing question is this. If hydrogen gas be one of the elements of water, *what has become of the other?* For if 700 hogsheads of hydrogen gas issue in a minute, about 250

* Philos. Trans. vol. 38. p. 113.

hogsheads of oxygen ought to accompany it, according to Davy ;* but, according to Mr Dumas, eight times that amount, or *two thousand tons of oxygen per minute*, ought to be the supply ; while not one hogshead, I believe, is to be found in the whole mine.

Can any rational man require the subject to be carried farther in order to prove that the hydrogen which composes the fire-damp, has never been generated by the decomposition of water ?

Now then let us bring to our recollection, what the ablest of our scientific chemists have themselves thought upon the subject of hydrogen. It is ascertained that Watt, to the latest moment, agreed with Stahl, and *regarded heat* as *material*, and to have the capacity of *combining with substances like other material elements*. He even went farther, and gave it as his opinion that " inflammable air" (hydrogen as it is now called), "*contains a small quantity of water and much elementary heat.*"† Priestley says, " that the water resulting from the explosure of hydrogen and common air, *he thought to be water held in mechanical solution.*" Priestley adds, that when Cavendish's paper on the formation

* Davy found four of hydrogen, and 11½ of charcoal formed the carburetted hydrogen ; the hydrogen being somewhat more than ⅓ of the composition.

† Watt says, that he " concluded from his experiments that *heat was a combining substance*, not merely modifying the form and condition of *elements*, but determining likewise *their permanent specific heat.*"

of water was read to the Royal Society, Cavendish told him "he was persuaded *that water was essential to the production of inflammable air.*"

It appears from other papers of Priestley, that he had at first concluded from several of his experiments, *that hydrogen was separated* from metals, such as zinc, tin, or iron, *by heat alone;* but he adds, that in all such experiments, *Cavendish* shewed him *that there was water present* in some form decomposed, and told him that water was essential to the production of inflammable air.* Priestley, as I have already noticed, denied that *pure* water could be produced *by any combination of oxygen and hydrogen, but invariably an acid liquor,* and which I have shewn would be the case if the inflammable air is water, combined with electricity.

To shew what little attention has been paid to the all-important question of the decomposition of water, and how easily a theory is adopted which flatters our vanity, I will borrow the following anecdote related by Mr. Babbage in his "Reflections on the Decline of Science in England," and quoted by Dr. Paris. "All gases," says Mr. Babbage, "being reducible to a liquid state by compression, I proposed to Sir Humphry Davy the question,

* See Priestley's Works, vol. vi. p. 87. In a very able article in the Quarterly Review for Dec. 1845, written to shew that Cavendish was the first discoverer of the decomposition of water, references will be found to the above quotations if they should be required. See the Quarterly Review for December, 1845, p. 105.

whether, if two volumes of hydrogen and one of oxygen are mixed together in a vessel, and if by *mechanical pressure* they can be so condensed as to become of the same specific gravity of water, the gases will unite and form water? Davy at once said, 'They will become water of course;' and on my inquiry whether the experiment would not be worth trying, he replied, it was hardly necessary to make it, *as it must succeed.*" On the same question being put by Mr. Babbage to Dr. Wollaston, he was of a contrary opinion, assigning as the cause the *nature of the electrical relations of the two gases remaining unchanged.*

It may be taken for granted that Dr. Wollaston did not pass over an experiment of this kind, and we may therefore conclude that it did not succeed. But the reason assigned by him for its failure seems deficient in force; as, according to the doctor's notions of electricity, the oxygen being charged positively and the hydrogen negatively, they would be in electric states the most favourable for combination.

But assuming that they were not so, what ground had Wollaston for supposing that when the two gases were inclosed in a vessel, and their union effected by the introduction of additional electricity, such addition would disturb the *nature of their electrical relations?* and if not, why does mechanical pressure fail?

I shall now conclude this part of my Inquiry with an appeal to the President and Council of the Royal

Society, and respectfully ask that influential body, whether, after deliberately weighing the arguments and evidence upon this important topic, they can think it consistent with the high character and more than European celebrity of the Society, constituted as it is for the especial promotion of science, and bearing on its banners the all-exciting and imperishable name of NEWTON, to remain quiescent spectators, and allow this all-absorbing question to slumber over the next half century?

Surely it must be the paramount duty, as well as the interest of the Society, to institute a series of experiments* under its direction, in order to determine, ONCE and FOR EVER, whether water is or is not a compound body; and if it is, what are the exact proportions of its elements; and further, whether hydrogen is or is not a compound of electricity and water.

It is evident that until these questions shall be determined, the science of Chemistry can exist only in name, and that we never can expect to derive from it any splendid discovery; for it is not to Chemists that we are indebted for the aid of steam and atmospheric air,—these had been the world's "chartered libertines" for untold ages; it is to the genius of the Mechanician that we owe our grati-

* If it should be asked why the author, when he entertains these opinions, does not bring forward some experiments of his own, he will be driven to confess that he is not an amateur chemist, and never made any experiment in chemistry, electricity, or magnetism, either personally or by proxy, in his life.

tude, who contrived to convert these unruly giants into sturdy labourers, and attach them to machines that claim our highest admiration.

Having thus disposed of the questions respecting water and hydrogen, I will now proceed to the consideration of the ELECTRIC and MAGNETIC fluids, and their mode of action.

I will here beg to premise, what I believe I shall be enabled at a future, and not far distant, period, to establish, should it not then have been ascertained, that the galvanic and magnetic fluids are modifications of the common electric fluid. That a combination of the latter fluid with the oxide of any metallic substance that has a powerful affinity for oxygen (such as zinc), forms the galvanic fluid; its energy depending upon the kind of acid which has produced the oxide; and that a combination of the electric fluid with an oxide of pure iron, forms the magnetic fluid.

In fact, that this powerful element is not only the basis of hydrogen, but also of the galvanic and magnetic fluids.

Davy and Wollaston held pretty much this opinion. Davy calls the metals "motors of electricity;" and Wollaston says "metallic oxidation is the primary cause."

Davy also says, "That the electric and galvanic fluids are the same, the apparent difference depending on the intensity and quantity." Davy again says, "that the *acid gives* and that the *alkali receives* the electricity;" and which, in fact, is nearly the

whole secret of the voltaic current, badly however expressed, as acid and alkali are only the two extremes of the conductor. He adds—"Atmospheric air or oxygen, or nitrous or muriatic acid in solution in the water, will produce the oxidation of the metals, *(but not pure water alone)*, and that the galvanic phenomena are in proportion to the *rapidity* with which the metals (the zinc particularly) are oxidated." This he afterwards repeats in another place, remarking, "that the plates will act no longer than the water between them holds *some oxygen* in solution; and that nitrous acid gives infinitely more energy to the fluid than the muriatic acid."*

It is extraordinary that the possibility of chemically uniting electricity or elementary heat with these aqueous and other matters, never forcibly struck any of our great chemists; and yet it will very likely turn out that these combinations are amongst the most useful of nature's processes, and produce the most curious results: but the ordinary and vulgar notion of fire and water being such opposite principles, that harmony can never exist between them, has intruded itself even into more philosophic minds, and made us repugn the idea of any combination of these elements being either probable or possible.

With regard to the nature of the electric fluid in its simple state, Franklin treated it as having two properties, the one positive and the other negative.

* See Dr. Paris's Life of Davy, vol. i. p. 246.

The French chemists believe that there are two distinct fluids, and we appear now to have adopted this conclusion.*

From the apparent mysterious mode of action of this matter, Davy thought "that the phenomena of electricity were produced by a highly volatile *fluid* or *fluids*, of which the particles are *repulsive with respect to each other, and attractive of the particles of matter!*"

Is it possible to imagine a definition more improbable or extraordinary than this! It is indeed the "ignotum per ignotius." But this must always be the case when absurd theories have to be accounted for.

Now all these theories are erroneous. There are no two fluids; there are no such things as positive and negative electricity; and the supposed attractive and repulsive properties have no existence.

The electric fluid, which is probably the cementing power which holds together the atoms of all substances,† *is constantly circulating* upon our

* For if there be but one fluid, thought the French chemists, how inconceivable it is that it should possess two opposite properties, as is in the magnet, one attractive and the other repellant, and that these two properties should be found in the smallest imaginable portion of the fluid, and yet be inseparable. Such a proposition would certainly not be likely to be very easy of digestion with men who had been dealing a little severely with miracles.

† Davy says—"I have shewn that chemical attractions may be exalted, modified, and destroyed by changes in the electric state of bodies."

globe from south to north; and it is from this simple fact alone, as I shall presently shew, that flow all the phenomena of electricity and magnetism which have puzzled the greatest men of modern times.

Every substance in nature is charged with more or less of the electric fluid, according to its constitution; and all excess of this fluid, existing on any matter whatever, passes from the matter into the general current; and this passage of the fluid necessarily takes place with more or less facility according as the body it is upon, is more or less a conductor of electricity.

"Common electricity," says Davy, "is *excited* (I should add, "and accumulated") *upon non*-conductors, and is readily carried off by conductors and imperfect conductors."

Now there are three sorts of substances, viz. conductors, (par excellence), imperfect conductors, and non-conductors.

To make myself perfectly intelligible, I will beg to state, that if we want to obtain any part of the electric fluid in circulation, for any purpose, we use a non-conductor, which being excited in the ordinary way, is found to be *charged* with an accumulation of the fluid, which is then, by a conductor, passed on to the Leyden jar, or any other apparatus, such jar or apparatus having been previously placed upon a stand furnished with glass or non-conducting feet, so that the fluid can have no escape from it, except through the atmosphere, and which when in a dry state is also a bad conductor.

Now if the electric fluid is perpetually circulating from south to north, it is evident that every portion of such fluid, and any modification of it, such as the magnetic fluid, which may have been so collected, must have a tendency to join and be carried with the fluid so in circulation. These simple data being premised, the consequences are self-evident.

For instance, suppose a rod of metal about fifteen inches long, and three quarters of an inch in diameter, *a*———*b*, to be charged with the common electric fluid, by introducing such fluid at the end, *b*. Now metal being an excellent conductor, it is clear that this fluid in order to pass with the general circulating fluid, will proceed instanter upon the rod from *b*, to the other end, *a*; and it is equally clear, that as the atmosphere is not nearly so rapid a conductor as the metal, the fluid, when it reaches *a*, must remain accumulated there, until by the slow conducting power of the air it is carried off to join the general current.

We will now come at once to the cause of the polarity of the magnetic needle, a problem which might have remained unsolved for ages, from the strong disposition of the mind for what is mysterious —the "omne ignotum pro magnifico."*

Let us take then a small steel bar, similar to

* It is a remarkable circumstance that the predilection for the marvellous is to be found in all grades of society.

The ablest mathematicians, and the closest logicians are tinctured with it as well as the uninstructed. About two years since I heard the celebrated French Astronomer and perpetual Secre-

what we see in a Dolland's pocket mariner's compass *a*———*b*. Now, if we wish to magnetise

tary of the Institute, Mr. Arago, say, in speaking of our sight, that we saw objects double, and those in an inverted position, defects which we only corrected by experience, or as he forcibly expressed it, by education. This doctrine, he told us, was founded upon experiments made by Chesselden and others upon persons born blind, and who, when they had acquired their sight, had their vision thus imperfect.

Now, instead of this strange and absurd doctrine (which I believe is not exclusively Mr. Arago's, and is to be found in the books), what does *common sense* say upon the subject? This, that the optic nerves of these patients from long want of use, could not perform instanter their functional duties, and that time would be required to enable them to recover their primitive power.

Will any man say that this is not a clear and natural and therefore a satisfactory reason? Why then resort unnecessarily to the marvellous?

We know that objects are inverted upon the retina; but does it follow as an inevitable consequence that the impression upon the mind is also inverted? Then why gratuitously assert as a fact that which is contradicted from our earliest experience?

This subject I more fully entered into, and illustrated in a paper, which appeared in the "Lancet" some months since, and which contained an experiment that removed all doubt upon the subject.*

I had sent the same paper some time previously to Sir David Brewster's "Philosophical Magazine" for insertion, but the Doctor thought proper to reject it, so indisposed are these great Professors and living Depositaries of "useful knowledge," to be put right upon any subject on which they are mistaken, and have been for years misleading the public.

* See "Lancet," 21st June, 1845, p. 719.

this bar, so that the north pole shall be at the end, *a*, we must pass the magnet along the bar from *b* to *a*, and always repeat the operation in that direction. If on the contrary we desire the north pole to be at *b*, we must pass the magnet the reverse way, or from *a* to *b*.

It is evident that in either way we produce a magnetic current, and therefore from whichever end this current escapes, that end (when the bar is suspended, so as to turn freely as in the compass), must point to the North Pole, such being the direction the fluid is travelling.

That this is the case will, I think, be indisputable, when we look at the effect of opposing current to current, as in the following experiment.

Let the bar of steel *a* ——— *b* receive the magnetic fluid in the direction *b*—*a*, that is by passing the magnet several times from *b* to *a*. Instead of now continuing the operation in the same direction, let the magnet be passed several times on the same bar from *a* to *b*. What follows? There will be now no polarity at either end of the bar, when it is suspended as before; and, therefore, for the purpose of indicating the North Pole, the bar will be useless. Why is this? Because, as must be manifest, by thus reversing the currents we oppose the current *a* to the current *b*, and which two currents must consequently meet in some *intermediate* part of the bar, where an accumulation of fluid will be formed, and where the fluid must escape

in the best way it can; for as neither current can return upon itself, so neither current can reach either extremity of the bar.

In this operation, therefore, the magnetic fluid will appear to be neutralized and its properties annihilated.

With regard to the phenomenon called the "Dipping of the Needle"—this no doubt arises from some inequality on the earth's surface, by which the fluid takes a downward course, and in that direction carries the needle. Or there may be large cavities near the surface containing metallic strata through which the fluid passes on its journey round the earth.

It will be hardly necessary to illustrate this magnetic theory farther, as the other phenomena will be explained by those resulting from electricity; but I will just notice the horse-shoe magnet, lest it should create a difficulty in the mind of the reader.

In this magnet, then, $_a\overset{b}{\cap}_c$ two currents exist, the steel in this form being magnetised from *b* to *a*, and from *b* to *c*.

It is evident, in this case, that the currents do not oppose each other, and consequently the strength of the magnet consists in having a double quantity of fluid, by a current terminating at each extremity.

The power called attraction is evidently nothing more than the tenacity with which the particles of the fluid adhere together, and in that state pass from conductor to conductor, thus causing an apparent cementing together of the two conductors.

We will now proceed to examine the supposed positive and negative properties of the common electric fluid, and in which the adhesion of the particles is not so great as in the magnetic fluid.

Suppose, then, two rods of brass, about fifteen inches long, and three-quarters of an inch in diameter, *a* 1 *b* *a* 2 *b*, and that each rod is charged with the common electric fluid, introduced at *b*.* It is evident that if these two rods, so charged, be placed on an isolated stand, the fluid will have accumulated at the end *a*, of each rod. Now, then, remark what follows. If I place the end *a*, of rod 2, in contact with the end *b* of the other rod, I shall form, as it were, but one conductor; and it is therefore evident that the fluid which existed on the rod No. 2, will have quitted that rod, and passed on to join the fluid of rod No. 1, at *a;* and if I charge a thousand rods, and place them together under the same circumstances, so as to form but one conductor, all the fluid will pass on to the first rod, on its way to join the general current.

Again, if I place the ends *b* of the two rods together, no phenomena will take place, it being evident that in this position of the rods there can be neither attraction nor repulsion, nor any other apparent property manifested, as the fluids are now travelling

* In all these experiments it is evident that the glass, or non-conducting handle, must be attached to the middle of the rods, so that their ends or extremities may be perfectly free.

in different directions, and wholly independent of each other.

But suppose, instead of placing the end *a* of one rod to the end *b* of the other, (which produced the phenomenon of attraction), we oppose the ends *a* of the two rods, that is, place them nearly together, what must be the manifest result? It is clear that the two accumulated fluids will be now placed in a state of antagonism, and that, like two currents of water, or any other two fluids in motion, opposed to each other, instead of attraction, a violent commotion will take place, and that all matters found or placed within their sphere of action must be forcibly carried away. Now, this antagonism taking place, with the magnetic, or the common electric fluid, produces the phenomenon called repulsion.

Thus, then, is explained all the mystery of attraction and repulsion, and of positive and negative properties, about which volumes have been written.

If, however, all the phenomena of electricity had been confined to these peculiarities, it is to be hoped, for the honour of science, and the acumen of its professors, that the occult nature of these operations would have been sooner brought to light.

It, however, happens that substances are met with upon which are found *only* positive electricity, as it is called; and upon others *only* negative electricity. Thus, then, it should appear as if there must be two fluids, as they are now seen detached; a circumstance not met with in the magnetic fluid,

as its attractive and repellant properties have not hitherto (I believe) presented themselves in a separate state, and which may arise from the tenacity of its particles.

Then, again, some substances will receive electricity from some bodies and refuse it from others, and *vice versa*, so that it is concluded that certain bodies will only receive a peculiar kind of electricity.

Now, this is all illusory, as will be readily understood and admitted upon examining a little farther into the nature of the different conducting bodies.

The common electric fluid is excited and collected (as we have seen) upon a body that does not conduct—for instance glass. Why? because the fluid must remain on such body in a comparatively motionless state—an uneasy state, to use a metaphor—a desire to leave but an incapacity to do so—a wish to arrive at the upper story of the building, but can find no staircase which leads to it. Suppose then the fluid to be now existing on such a surface.

Suppose again a *conducting* body to be charged with the electric fluid—(one of the metallic rods for instance), which has received such fluid at *b*. Now place the end *a*, of this rod (the positive end as it is called), where the fluid has concentrated itself, in contact with the fluid which is stagnant on the non-conducting body. It is plain that in this case there can be no attraction—why? Because both the fluids are endeavouring to escape, and in this situation neither of them offers to the other any facility or

means of so doing ; on the contrary, the result of their approximation is to produce a scuffle between them to the advantage of neither. But instead of the positive end, *a*, place the negative end, *b*, of this conductor on the non-conducting body, and you immediately discharge the latter of its electricity.

Now to account for this result, instead of the above simple explanation, our scientific men have created two fluids, calling that upon the metallic rod the positive, and that upon the non-conducting body the negative fluid ; and they have assumed from the above experiments, that there exists a warm attachment (affinity) between the positive and negative families, while on the contrary these two mysterious fluids, as between themselves, that is when in their separate establishments and confined to their respective houses, are upon terms of utter enmity, and that nothing but discord reigns between them.

It is found again that the electric fluid upon two non-conducting substances will not unite ; that when one non-conducting substance, charged with the electric fluid, is presented to another non-conducting body also charged, no sympathy takes place between them, but quite the contrary. I have already given the reason of this, namely, that both fluids are in an imprisoned state, their motion in a current being suspended ; and as each fluid is seeking (if I may be at liberty to use this expression) to escape, it is evidently not the union of the two fluids which can effect the object, but a conducting

body, which neither of them possesses ; and consequently placing the two non-conducting substances together only embarrasses their condition. The result then is that a juxta-position of two bodies under these circumstances produces no other phenomenon than repulsion.

Now, there occurred a circumstance which enveloped this occult subject, (as it appeared to the great practitioners of electricity), in impenetrable obscurity, and called in vain for professional ingenuity to account for.

Dr. Faraday found that a metallic ball isolated—that is, suspended in the open air by a silken string, would receive or be charged with the electric fluid (by induction, as the Doctor calls it), from the atmosphere.

This, according to what I have laid down, is an inevitable consequence. The fluid being always in circulation, and metal being a powerful conducting surface, the ball must in this case be charged with electricity.

But the surprise of Dr. Faraday arose from his finding, that notwithstanding the ball was of metal, and therefore the best of conductors, it was charged with the *negative* fluid ; and I will venture to add, that the Doctor was never more surprised in his life.*

Now this again, according to the theory I have stated, is not only perfectly intelligible, but is also

* See Dr. Faraday's paper in Sir David Brewster's Philos. Mag. of June, 1843, p. 478.

a necessary consequence; whereas according to the theory of the books, it can in no shape be accounted for, and must have been in direct opposition to all Doctor Faraday's ideas upon the subject.

I have already stated that a body is a non-conductor, or an extremely bad conductor, when the fluid rests upon it in a comparatively torpid or imprisoned state, the natural condition of the fluid being that of a current, which in this case is suspended.

It is evident, therefore, that although metal is an excellent conductor, it may be so shaped as to have all the disadvantage of a non-conductor, and in that case, all the difference that can exist between a metal and a non-conducting body will be, that the metal will be charged by induction (that is, by exposure to the atmosphere), with the *greatest* quantity of fluid.

Now, when the metal is formed into a ball, it is precisely of the shape in which it must act as a non-conducting surface or body.

How can the electric fluid pass off from the metal in this shape, better than it could from any non-conducting surface? But the moment this same ball of metal is by the hammer elongated, and offers an extremity or end for the fluid to escape from, the metal will then be positively charged by induction or exposure to the atmosphere.

However, to put this subject beyond the possibility of cavil, and to prove, incontrovertibly, that

the ball is charged with the supposed negative fluid, solely from the cause I have mentioned, if, when the ball is so charged, a short metallic rod | $\frac{a}{b}$ be placed upon, or attached to, the ball with the upper end *a* pointed, so as to facilitate the transit of the fluid into the atmosphere, the fluid on the ball will be found *immediately changed from a negative to a positive fluid;* and it will be also found that so long as the pointed rod remains affixed to the ball, it will be impossible to charge it, by induction or otherwise, with negative fluid.

It is evident, that through the medium of the rod attached to the ball a current will be aided; and from that moment the fluid will resume its natural motion, and become, to all intents and purposes, according to the nomenclature of the day, a positive fluid.

I will now say a few words respecting the *modus operandi* of the voltaic pile.

All bodies appear to be in different states of electricity, according to their respective natures, and this fluid, in all probability, constitutes (as I have before said) the cementing or connecting power by which the particles of matter are held together.

When the active power of this fluid is made more energetic by that combination of it with some other body, which converts it into what is called the galvanic fluid, it has the virtue of disintegrating or separating certain compound substances; and which it possibly effects in as simple a manner as the

crystals of sugar are dissolved in warm water, and from the same cause, viz. a superfluity of fluid beyond what is necessary for the adhesion of the particles of matter ; in fact, an inundation of fluid or elementary heat.

The construction of the voltaic pile is such as to compel this fluid to travel in a circle, and in so doing it necessarily passes from the negative, or least conducting pole or substance, to the positive pole or greater conducting surface; and by this means the whole of the fluid is made to act, in its transit, upon any given substance required to be operated upon.

When the resolution of a compound body takes place, the substances of which it is compounded will arrange themselves according to the order of their electric capacities, (which can be readily imagined from what has been already written) that is, the body which has as great or a greater conducting power than the substance forming the positive pole will pass to that side, and the bodies having a less conducting power than the substance forming the negative pole will attach themselves to the latter, and thus extend the conductor of the fluid according to their respective electric capacities.

Here, then, we again find the same absence of all that complexity and mystery in which most of our subtle philosophers fondly indulge themselves, from the very mistaken notion, no doubt, that superiority of intellect is denoted by the extrava-

gance of its conceptions, (which they are pleased to call Genius) and that plain common sense is much below their dignity.

It is curious to observe the inconsistency which exists with respect to the electric fluid. When hydrogen and oxygen are to be converted into water, the agent the chemists call in to effect the union of these gases, is this fluid. But this is the *solitary* instance in which this elementary power is made to perform an hymeneal office; in every other case, they represent it as the universal enemy of nature; the deranger of all sympathy; the destroyer of all conjugal felicity, however long and sincere the attachment may have been, and however disinclined the parties may be to separate.

They may, however, ultimately discover that the electric fluid, when better known, is as much disposed, and as capable of forming harmonious compacts as any other of its elementary companions; and that it is to some one of those friendly unions that we stand indebted for the inestimable blessings of Light and Heat, which Davy, in the recklessness of an unchastened imagination, concluded to be mere *accidents* in nature, produced by tumult and violence, or, as he called it, "intense action."

Thus, then, do all the phenomena we meet with in electricity and magnetism (except light and heat), flow from the simple circumstance, *of the continuous circulation of these fluids from south to north upon the surface of our globe.*

However strange and incredible, therefore,—(considering the variety of the phenomena)—this theory may appear, and however it may call forth the opposition of those philosophers, who seem to hold simplicity in abhorrence, I shall continue, like Galileo, to exclaim laconically, but emphatically, It is nevertheless so!

ADDENDA.

The author's Theory of the Phenomena of the Electric and Magnetic Fluids, and their mode of action, suggested itself to his mind during an illness at Aix-les-bains in Savoie, and was thence communicated by him to the "Royal Society," in a paper transmitted to their excellent Secretary, Dr. Roget, in August, 1834, and subsequently to Dr. Faraday, in January, 1838.

The subject was referred by the Society to a Committee, but no report was ever made.

In December, 1834, the same Theory was communicated by the author to the "French Institute," in a memoir presented by M. Arago, when the subject was referred to Messieurs Ampère and Becquerel, but they never made any report.

The author also communicated the Theory of the Magnetic Needle to the "Board of Admiralty," in a paper transmitted in February, 1838.

Early in 1844, in consequence of seeing in the Philosophical Magazine of Sir David Brewster, for June, 1843, Dr. Faraday's experiment noticed in the foregoing pages, the author addressed another memoir to the "Royal Society," accounting for the phenomenon, and shewing that it flowed from, and was confirmatory of, his Theory.

The same communication was also sent, in March, 1844, to Sir David Brewster's Philosophical Magazine; but it was never published, as the author believes.

The Theory as to the Non-Decomposition of Water, and that Hydrogen was composed of Electricity and Water, was communicated to the Royal Society in a memoir forwarded from the continent to Dr. Roget, in April, 1840, and which was referred by the Council to the "Committee of Chemistry," who have made no report thereon.

A similar paper was sent to the Marquis of Northampton, in May, 1840.

In December, 1841, the author addressed another memoir upon the same subject to the Royal Society, accompanied with the dicta of Cavendish, Priestley, and Watt, as to Hydrogen being a compound body, which was also referred to the "Committee of Chemistry," but without any result.

THE END.

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